Experiment No.7
Aim: To implement Booth's algorithm using c-programming
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Aim: To implement Booth's algorithm using c-programming.

Objective -

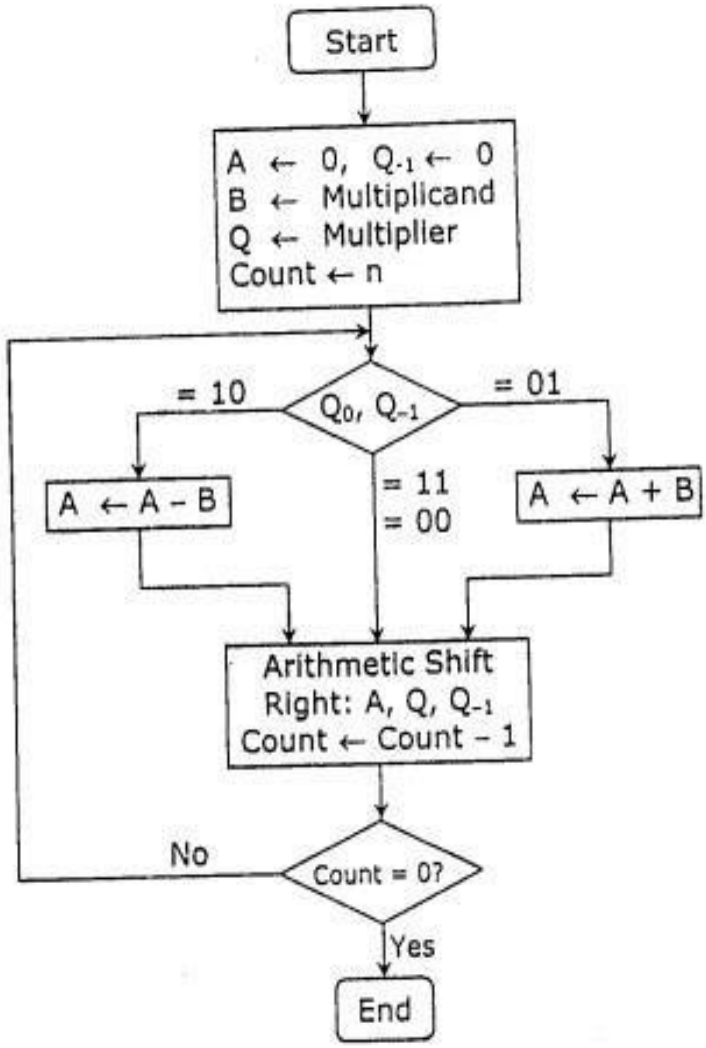
1. To understand the working of Booths algorithm.
2. To understand how to implement Booth's algorithm using c-programming.

Theory:

Booth's algorithm is a multiplication algorithm that multiplies two signed binary numbers in 2's complement notation. Booth used desk calculators that were faster at shifting than adding and created the algorithm to increase their speed.

The algorithm works as per the following conditions :

1. If Qn and Q_{-1} are same i.e. 00 or 11 perform arithmetic shift by 1 bit.
2. If Qn Q_{-1} = 10 do A= A - B and perform arithmetic shift by 1 bit.
3. If Qn Q_{-1} = 01 do A= A + B and perform arithmetic shift by 1 bit.



Multiplicand (B) ← 0 1 0 1 (5), Multiplier (Q) ← 0 1 0 0 (4)				
Steps	A	Q	Q_{-1}	Operation
	0 0 0 0	0 1 0 0	0	Initial
Step 1 :	0 0 0 0	0 0 1 0	0	Shift right
Step 2 :	0 0 0 0	0 0 0 1	0	Shift right
Step 3 :	1 0 1 1	0 0 0 1	0	A ← A − B
	1 1 0 1	1 0 0 0	1	Shift right
Step 4 :	0 0 1 0	1 0 0 0	1	A ← A + B
	0 0 0 1	0 1 0 0	0	Shift right
Result	0 0 0 1 0 1 0 0 = +20			

Program:

```
#include <stdio.h>
#include <math.h>

 int a = 0,b = 0, c = 0, a1 = 0, b1 = 0, com[5] = { 1, 0, 0, 0, 0};
int anum[5] = {0}, anumcp[5] = {0}, bnum[5] = {0};  int
acomp[5] = {0}, bcomp[5] = {0}, pro[5] = {0}, res[5] = {0};

 void  binary(){     a1  =
    fabs(a);         b1     =
    fabs(b);   int  r,  r2,  i,
    temp;  for (i = 0; i <
    5; i++){  r = a1 % 2;
    a1 = a1 / 2;  r2 = b1
    %  2;   b1  =  b1  /  2;
    anum[i]       =       r;
    anumcp[i]      =      r;
    bnum[i] = r2;  if(r2
    == 0){   bcomp[i] =
               1;
           }   if(r == 0){
          acomp[i] =1;
           }
     }
  //part for two's complementing
   c = 0;  for ( i = 0; i < 5; i++){
  res[i] = com[i]+ bcomp[i] +
  c;  if(res[i] >= 2){   c = 1;
          }
          else
               c = 0;
           res[i] = res[i] % 2;
    }    for (i = 4; i >= 0;
  i--){
     bcomp[i] = res[i];
  }
   //in case of negative inputs
  if (a < 0){
```

```
    c = 0;   for (i = 4; i
   >= 0; i--){
        res[i] = 0;   }   for ( i = 0; i
   < 5; i++){  res[i] =
       com[i] + acomp[i] + c;  if
       (res[i] >= 2){
            c = 1;
       }
       else
            c = 0;
        res[i] = res[i]%2;
   }   for (i = 4; i >= 0; i-
   -){  anum[i] = res[i];
   anumcp[i] = res[i];
    }

  }   if(b <
  0){
    for (i = 0; i < 5; i++){
       temp = bnum[i];
       bnum[i] = bcomp[i];
       bcomp[i] = temp;
    }
  }
}    void add(int num[]){  int i;  c
= 0;  for ( i = 0; i < 5; i++){  res[i]
= pro[i] + num[i] + c;  if (res[i]
   >= 2){   c =
        1;  }
        else{
            c = 0;  }
       res[i] = res[i]%2;
    }   for (i = 4; i >= 0;
   i--){  pro[i] = res[i];
   printf("%d",pro[i]);
    }    printf(":");   for (i = 4; i
  >=   0;   i--){      printf("%d",
  anumcp[i]);
```

```
    }
 }    void arshift(){//for arithmetic shift right    int
temp = pro[4], temp2 = pro[0], i;  for (i = 1; i < 5  ;
i++){//shift the MSB of product
       pro[i-1] = pro[i];
    }
     pro[4] = temp;  for (i = 1; i < 5  ; i++){//shift
    the LSB of product
       anumcp[i-1] = anumcp[i];
    }
     anumcp[4] = temp2;  printf("\nARSHIFT:
    ");//display together  for (i = 4; i
    >= 0; i--){  printf("%d",pro[i]);
    }   printf(":");
    for(i =
    4; i >= 0; i--){
      printf("%d", anumcp[i]);
    }
}
 void main(){
   int i, q = 0;
    printf("\t\tBOOTH'S MULTIPLICATION ALGORITHM");
   printf("\nEnter two numbers to multiply:
   ");  printf("\nBoth must be less than 16");
   //simulating for two numbers each below
   16      do{      printf("\nEnter    A:    ");
   scanf("%d",&a);     printf("Enter   B:   ");
   scanf("%d",  &b);     }while(a  >=16  ||  b
   >=16);

     printf("\nExpected product = %d", a *
    b);      binary();      printf("\n\nBinary
    Equivalents are: ");   printf("\nA = ");
    for (i = 4; i >= 0; i--){
       printf("%d", anum[i]);
     }   printf("\nB = ");
    for
```

```
(i = 4; i >= 0; i--){
   printf("%d", bnum[i]);
 }   printf("\nB'+ 1 =
");
for (i = 4; i >= 0; i--){
    printf("%d", bcomp[i]);
 }   printf("\n\n");  for (i = 0;i < 5;
i++){  if
(anum[i] == q){//just shift for 00 or 11   printf("\n-
          -
          >");  arshift();
          q = anum[i];
       }
      else if(anum[i] == 1 && q == 0){//subtract and shift for 10
          printf("\n-->");
         printf("\nSUB      B:      ");
         add(bcomp);//add      two's
         complement to implement
         subtraction   arshift();   q =
         anum[i];
      }    else{//add ans shift for
      01   printf("\n-->");
         printf("\nADD B: ");
         add(bnum);
          arshift();  q
         = anum[i];
      }
}

 printf("\nProduct is = ");
for (i = 4; i >= 0; i--){  printf("%d",
pro[i]);
 }
 for (i = 4; i >= 0; i--){
      printf("%d", anumcp[i]);
 }
}
```

Output:

```
                BOOTH'S MULTIPLICATION ALGORITHM
Enter two numbers to multiply:
Both must be less than 16
Enter A: 5
Enter B: 2

Expected product = 10

Binary Equivalents are:
A = 00101
B = 00010
B'+ 1 = 11110


-->
SUB B: 11110:00101
AR-SHIFT: 11111:00010
-->
ADD B: 00001:00010
AR-SHIFT: 00000:10001
-->
SUB B: 11110:10001
AR-SHIFT: 11111:01000
-->
ADD B: 00001:01000
AR-SHIFT: 00000:10100
-->
AR-SHIFT: 00000:01010
Product is = 0000001010

...Program finished with exit code 1
Press ENTER to exit console.
```

Conclusion -

Implementing Booth's algorithm in C provides an efficient method for multiplying binary numbers using signed integers. This algorithm reduces the complexity of multiplication by transforming the problem into a series of shifts and adds, leveraging the properties of binary arithmetic. By coding Booth's algorithm, you can effectively handle signed multiplication operations, which is particularly useful in low-level programming and digital systems design. The algorithm's systematic approach ensures that multiplication operations are performed accurately and efficiently, even when dealing with negative numbers.